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Magnetic Fields in Cygnus A Wilson, Young & Shopbell

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Chandra Observations of Cygnus A: Magnetic Field Strengths in the Hot Spots of a Radio Galaxy

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abstract We report X-ray observations of the powerful radio galaxy Cygnus A with the Chandra X-ray Observatory. This letter focuses on the radio hot spots, all four of which are detected in X-rays with a very similar morphology to their radio structure. X-ray spectra have been obtained for the two brighter hot spots (A and D). Both are well described by a power law with photon index $\Gamma = 1.8 \pm 0.2$ absorbed by the Galactic column in the direction of Cygnus A. Thermal X-ray models require too high gas densities and may be ruled out. The images and spectra strongly support synchrotron self-Compton models of the X-ray emission, as proposed by Harris, Carilli & Perley on the basis of ROSAT imaging observations. Such models indicate that the magnetic field in each of the brighter hot spots is 1.5×10^{-4} gauss, with an uncertainty of a few tens of percent. This value is close to the equipartition field strengths assuming no protons are present. The possibility that the X-rays are synchrotron radiation is briefly discussed, but not favored. We speculate that production of the $\gamma \sim 10^7$ electrons necessary for X-ray synchrotron radiation from hot spots is inhibited when the external gas density is high, as is the case when the radio galaxy is within a cooling flow.